Jupiter Halo Orbits and the Motions of Minor Bodies

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The motion of minor bodies under the influence of Jupiter, but which are not within its Hill stability region, are controlled by the invariant manifolds of the Sun-Jupiter Lagrange points. It is well known that the trajectories of the Trojan and Greek asteroids oscillate about Jupiter's L4 and L5 Lagrange points. Recent work of Lo and Ross shows that the invariant manifolds of L1 and L2 play a significant role in the distribution and transport of material within the Solar System. However, the stable and unstable manifolds of L1 and L2 are in the two degree of freedom system. To understand the motions of the minor bodies in this region of phase space, one must consider the higher dimensional structures. The next simplest objects to examine after the Lagrange points, are the periodic orbits about L1 and L2 known as halo orbits, Their stable and unstable manifolds form a cylinder about the stable and unstable manifolds of L1 and L2. This paper examines how the invariant manifolds of halo orbits affect the motion in the full three degree of freedom system. Careful comparison of the motions of the Jupiter family comets with the halo orbit manifolds demonstrate that these manifolds do control the motions of the comets. The computation of the manifolds and orbits uses a software package, LTool, developed jointly by JPL and Purdue University. The manifold calculation algorithm, based on Floquet theory, is easily parallelized. LTool takes advantage of this inherent parallel structure and has a distributed architecture. The manifold visualization tool, LVis, is developed in OpenGL to enable the use of immersive visualization techniques.